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ART UNIT	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Applicati n No. 09/902,673	Applicant(s) FUNABASHI, MICHIMASA	
	Examiner Lex Malsawma	Art Unit 2825	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 May 2002* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *20-32* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *20-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. *09/392,568* .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 20-23 and 25-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ohmi et al. (5,990,060, hereinafter, "Ohmi") in view of Wang (6,087,243).

Regarding Claims 20-23, 25, and 27:

Ohmi discloses the following:

a processing solution containing hydrogen peroxide, hydracid fluoride salt (e.g., tetraalkyl ammonium fluoride), and water (note TABLE 1, in col. 9);

the processing solution includes HF and HF_2^- as etching seeds of silicon oxide (note col. 2, lines 32-34);

the processing solution can be utilized with ultrasonic vibration during the cleaning of a silicon wafer (note col. 3, line 67 to col. 4, line 44);

the processing solution can be utilized for cleaning the silicon wafer at a temperature as low as 40 °C (note col. 5, lines 7-16);

the processing solution is used to remove foreign materials deposited on a substrate after photoresist for ion injection or reactive ion etching is removed (note col. 2, lines 7-13); and

a method of utilizing the processing solution comprising:

(a) providing a silicon wafer 3 covered with an insulating film 3 whose main surface is mainly formed of silicon oxide 4 (note Figs. 3), wherein the surface contains foreign material 6 from a previous step of removing a photoresist (note Fig. 5); and

(b) cleaning the surface of said silicon wafer with said processing solution such that the foreign material 6 is removed from the mainly silicon oxide surface (Fig. 6).

Ohmi **lacks** the following:

(1) specifying the concentration of said hydracid fluoride salt in units of mol/L, i.e., specifying the concentration in terms of molarity;

(2) the device manufacturing process step (c) of removing the insulating film after the step (b) of cleaning to expose the surface to the silicon wafer; and

(3) the device manufacturing process step (d) of subjecting the silicon wafer to a heat-treatment after step (c) thereby to form a gate oxide film over the silicon wafer.

In regards to lacked-limitation (1), Ohmi specifies the density of ammonium fluoride (i.e., the hydracid fluoride salt) is in a range of 0.05 to 49 weight % (note the sentence bridging cols. 2-3), and if tetra-methyl ammonium fluoride is used for the hydracid fluoride salt, then the density is in the range of 0.05 to 60 weight %. In other words, if ammonium fluoride (NH_4F, formula weight = 37 grams, i.e., 1 mole of NH_4F weighs 37 grams) is used as the hydracid fluoride salt, and if the density specified by Ohmi is interpreted in grams/liter (g/L), then Ohmi could be interpreted as specifying a range of 0.05 to 49 grams per liter (i.e., a range of 0.05g/L to 49g/L of NH_4F), which would convert to a range in molarity of about 0.0013 *M* to 1.324 *M* (i.e., an range of 0.0013 mol/L to 1.324 mol/L of NH_4F). It is noted that no specific hydracid fluoride salt is specified in Claim 20, therefore, the claimed range in molarity (i.e., 0.1 to 3 mol/L) is in

the very least held obvious over Ohmi, since Ohmi could be interpreted as disclosing a molarity within the claimed range. In any case, Ohmi discloses the general conditions for the processing solution with similar concentrations for the hydracid fluoride salt, and it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233. Therefore, lacked-limitation (1) is not considered to have patentable weight because Ohmi's disclosure could include concentrations within the claimed range.

In regards to lacked-limitations (2) and (3), it important to note that Ohmi does not disclose, or is not specifically concerned with disclosing, process steps for forming any particular device, but rather, Ohmi discloses only process steps (or conditions) necessary to clean a substrate utilizing the processing solution. In other words, Ohmi discloses a most important aspect of the current invention, i.e., a processing solution which contains hydrogen peroxide, hydracid fluoride salt, and water; and Ohmi discloses only pertinent steps for utilizing the processing solution in a cleaning process, wherein the cleaning process would be just one process out of a plurality of processes that would be required during a semiconductor device fabrication, for example, other processes such as an ion-implantation process, a metallization process, a via forming process, etc. would also be necessary in a semiconductor device fabrication. Wang is cited to show processes that would typically be included in a semiconductor device fabrication. Wang **teaches** (in col. 2, lines 12-41) a pad oxide layer (i.e., a sacrificial oxide layer) is first formed on a surface of a substrate; various process steps are then performed, including an ion implantation step to form a retrograde well (note col. 2, lines 30-31); then remaining portions of the pad/sacrificial oxide layer is then removed (col. 2, lines 36-37);

and after removal of said remaining portions, a gate oxide film is grown over the silicon wafer, wherein the gate oxide would most probably be thermally grown (note col. 2, lines 38-40) as is common in the art. The following important note is necessary at this point:

> In regards to Wang's disclosure of performing an ion implantation step (to form a retrograde well) prior to removing the remaining pad/sacrificial oxide, one of ordinary skill in the art would have realized that the ion implantation step would be performed by utilizing a resist pattern which is later removed, even though Wang does not specifically disclose the steps for the ion-implantation process. For example, note Ohmi's disclosure in col. 5 (lines 41-50), "[r]esist is always required from the photolithographic process to the next ion implantation process...". One of ordinary skill in the art would realize that numerous resist patterning and removal steps are generally required during device fabrication, wherein according to Ohmi's disclosure, the cleaning solution (and process of cleaning) would be utilized at least after one resist-pattern-removal step, more specifically, Ohmi would be applied after removing a resist pattern which had been formed on top of a silicon oxide layer (note again, Ohmi's Figs. 3-6).

Returning to Wang, in Figs. 1A-1D and col. 6 (line 19) to col. 7 (line 25), a specific device manufacturing process is disclosed, and initially, it is noted that this process is very similar to the process disclosed in the current specification (see Figs. 3-8, 10, and 11 of Applicants' drawings). The point being made is that both Wang and Applicant are utilizing the common practice of:

> (i) forming a pad/sacrificial oxide on a silicon wafer;
>
> (ii) performing various processing steps including an ion implantation step "utilizing a resist mask" to form a well, wherein the resist mask is formed directly on the

pad/sacrificial oxide layer;

(iii) removing the resist mask which was formed on the pad/sacrificial oxide;

(iv) removing portions of the pad/sacrificial oxide layer; and

(v) growing a gate oxide film over the silicon wafer.

In regards to the instant claims, the issue of patentability rests on whether or not it would have obvious to one of ordinary skill in the art to utilize Ohmi's processing solution (and cleaning process) to clean the silicon wafer after step (iii) but before step (iv) of said common practice. Ohmi teaches the processing solution (and cleaning process) was invented for the very purpose of removing foreign material remaining on the surface of a silicon oxide layer (i.e., a pad/sacrificial oxide surface), wherein the foreign material is a direct result of removing a resist mask which had been formed on the silicon oxide surface. Ohmi discloses in "Background Technology", cols. 1-2) prior art problems associated with foreign materials remaining after resist removal; and in col. 2 (lines 8-20), col. 3 (lines 42-47), and col. 11 (lines 29-36), Ohmi discloses the advantages of cleaning a wafer surface utilizing the processing solution. Therefore, ***it would have been obvious*** to one of ordinary skill in the art to implement Ohmi into a typical semiconductor manufacturing process (similar to that shown by Wang), wherein Ohmi's processing solution (and cleaning process) is utilized after a step of removing a resist mask which had been formed on a pad/sacrificial oxide layer ***because*** problems caused by foreign materials (from the resist mask) remaining on the pad/sacrificial oxide surface can be avoided, since Ohmi's processing solution and cleaning process will remove the foreign materials with an additional advantage of being able to perform the cleaning process at a low temperature (note Ohmi, col. 1, lines 51-65, and col. 5, lines 7-10).

Regarding Claim 26:

Ohmi (in view of Wang and Okutani) discloses the general conditions of the instant claim, however, Ohmi does not specify any particular range for pH. It would have been obvious to one of ordinary skill in the art to specify a pH in a range of 6 to 11 for the processing solution, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges (i.e., range in pH) involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

3. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohmi (in view of Wang) as applied to Claim 20 above, and further in view of Ohmi et al. (5,277,835, hereinafter, " '835 Patent").

Regarding Claim 24:

Ohmi (in view of Wang) **lacks** a surfactant being included in the processing solution. The '835 Patent **teaches** it was well known in the art to include a surfactant into a processing solution wherein the wettability of the processing solution can be improved such that smoothness of a surface being treated can be achieved during a cleaning step (note col. 1, line 62 to col. 2, line 52). It would have been obvious to one of ordinary skill in the art to modify Ohmi (in view of Wang) by including a surfactant because the '835 Patent teaches such a modification could ensure smoothness of a surface being cleaned by the processing solution.

4. Claims 28, 29, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ohmi (in view of Wang) as applied to Claim 20 above, and further in view of Okutani (5,135,608).

Regarding Claims 28 and 29:

Wang teaches the pad/sacrificial oxide layer is removed with dilute hydrofluoric acid (HF) prior to subjecting the substrate to the heat-treatment to form the gate oxide film (note col. 2, lines 36-40). However, Ohmi (in view of Wang) **lacks** specifically disclosing that the substrate is dried before forming the gate oxide by the heat-treatment step. One of ordinary skill in the art would have realized that, in a process as specified by Wang, a drying step would be performed before the heat-treatment step, and Okutani is cited to show that it was very well known in the art to thoroughly dry a substrate after a wet process. Okutani **teaches** (note Fig. 1 and abstract) a multi-module apparatus with an arrangement comprising a wet processing chamber and several dry processing chambers, wherein the arrangement allows dry processing and wet processing to be continuously effected without exposing the wafer to air (i.e., a contaminating atmosphere outside of the apparatus). Okutani teaches (col. 4, lines 27-41) that a wafer which has undergone wet processing is thoroughly dried before any subsequent dry processing is performed. It is important to note that Okutani's apparatus has the ideal features necessary for implementing Ohmi's cleaning solution/process and Wang's process into a semiconductor device manufacturing method. It would have been obvious to one of ordinary skill in the art to modify Ohmi (in view of Wang) by specifying a drying process prior to the heat-treatment because Okutani teaches it was well known in the art to thoroughly dry a substrate

after a wet process and an apparatus having ideal features to perform such a drying process would have been available at the time the current invention was made.

Regarding Claim 30:

The apparatus disclosed by Okutani allows transportation of the substrate directly from one processing chamber (wet or dry processing) to another processing chamber without exposing the silicon wafer to (a contaminating) atmosphere. Furthermore, the apparatus includes means for immediately transferring a substrate to another processing chamber after a thorough drying process, therefore, the instant claim is held obvious over the cited references.

5. Claim 32 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohmi (in view of Wang) as applied to Claim 20 above, and further in view of Hazama et al. (5,162,880) and Hwang (5,512,519).

Ohmi (in view of Wang) **lack** performing another heat-treatment in an atmosphere of NO or N_2O to segregate nitrogen at the interface between the gate oxide and the silicon wafer. Hazama et al. **teach** a method of forming carrier traps in a gate oxide film, wherein the carrier traps can significantly improve performance of nonvolatile semiconductor memory cells (note abstract and col. 1, line 15 to col. 2, line 22). Hazama et al. teach the method comprises thermally oxidizing a substrate 11 to form a gate oxide film 14 (Fig. 5b and col. 4, lines 38-41) and performing another heat-treatment in a nitrogen atmosphere to form carrier traps 13 within the gate oxide, wherein the carrier traps are located at an interface between the gate oxide and the substrate (note Fig. 5c and col. 4, lines 54-57). Hazama et al. do not specify any particular source for generating the nitrogen atmosphere. Hwang is cited primarily to show it was very

well known in the art to utilize either NO or N_2O in order to provide a nitrogen containing atmosphere. Note Hwang discloses that nitrogen atoms are located at the Si/SiO_2 interface by conducting a heat-treatment in NO gas (col. 2, lines 64-67). It would have been an obvious matter of design choice for one of ordinary skill in the art to modify Ohmi (in view of Wang) by performing another heat-treatment in a nitrogen atmosphere utilizing either NO or N_2O because of the following reasons:

It was well known in the art to form a gate oxide layer comprising nitrogen atoms at the gate-oxide/substrate interface, wherein locating nitrogen atoms in such a manner can be achieved by a heat-treatment in NO or N_2O (as shown by Hwang);

it was well known in the art that heat treating a gate oxide layer in a nitrogen atmosphere can provide significant benefits to a particular type of semiconductor device (as taught by Hazama et al.);

performing another heat-treatment in a nitrogen containing atmosphere would depend largely on the particular type of semiconductor device being fabricated;

Applicant does not specifically claim any particular type of semiconductor device being fabricated; therefore,

incorporating another heat-treatment (as instantly claimed) would have been a matter of design choice, since such an incorporation would depend on a particular semiconductor device being fabricated or on a particular design need, wherein the benefits of such a heat-treatment were well known in the art at the time the current invention was made.

6. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ohmi (in view of Wang and Okutani) as applied to Claim 30 above, and further in view of Hazama et al. (5,162,880) and Hwang (5,512,519).

The instant claim is similar to Claim 32, and in general, Ohmi (in view of Wang and Okutani) disclose the general conditions of the claimed invention except for performing another heat-treatment in an atmosphere of NO or N_2O. Hazama et al. and Hwang are cited to show it was well known in the art to subject a gate oxide layer to a heat-treatment in a nitrogen atmosphere (utilizing NO or N_2O). Therefore, with similar reasoning applied to Claim 32 above, the instant claim is held obvious over the cited references, i.e., it would have been an obvious matter of design choice to perform another heat-treatment (in a nitrogen atmosphere), since such a choice could depend primarily on a specific type of semiconductor device being fabricated.

Remarks

7. Applicant's remarks have been carefully review and fully considered, however, they are moot in view of the new grounds of rejections. In general, all pending claims are held obvious over the cited references primarily because Ohmi (5,990,060) discloses a critical aspect of the current invention, i.e., Ohmi discloses a processing solution as currently claimed. The point, during the manufacturing process, at which Applicant specifically cleans the substrate with the currently claimed processing solution would be the ideal time to utilize Ohmi's processing solution (and cleaning process) because Ohmi specifies the processing solution was invented for the purpose of removing residual material remaining after photoresist is removed, wherein the photoresist was utilized for processes including ion implantation, reactive ion etching, and/or

plasma processing. It is noted that Applicant specifies that the cleaning step is performed after removing a photoresist mask which was formed on a silicon oxide layer, wherein the photoresist mask was utilized during ion implantation/injection (note photoresist "9" and silicon oxide "5" in Figs. 7-10 of Applicant's drawings; and specification page 14, lines 2-21).

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Pong et al. (5,210,056), Hong (5,525,535), Sung (5,550,078), Takeuchi (5,661,056), and Saga et al. (5,679,171) are cited to show typical process steps comprising pad/sacrificial oxide formation and removal prior to gate oxide formation, wafer cleaning using similar processing solution, performing a heat-treatment in a nitrogen atmosphere, etc.

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lex Malsawma whose telephone number is 703-306-5986.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 703-308-1323. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Lex Malsawma

July 23, 2002

MATTHEW SMITH
SUPERVISORY PATENT EXAMINER
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